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HIGH QUALITY ADHESIVE ANALYSIS

Luke A. Lorang, 1Lt, USAF

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ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
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APPROVED: Joseph B. Brauer

JOSEPH B. BRAUER
Chief, Microelectronics Reliability Division
Directorate of Reliability & Compatibility

APPROVED: John J. Bart

JOHN J. BART
Technical Director
Directorate of Reliability & Compatibility

FOR THE COMMANDER: James W. Hyde III

JAMES W. HYDE, III
Directorate of Plans & Programs

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16. SUPPLEMENTARY NOTATION In-house work unit entitled High Quality Adhesive Analysis was terminated in Jul 86 and funding was cancelled. Principal investigator for the project was William C. Stewart (RBRE).

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The purpose of this in-house project was to characterize organic adhesives used or being considered for use in microelectronic packages and assess their impact on reliability. Based on the results of the adhesive characterization, a specification would be generated defining the critical properties required of these adhesives. A minimal amount of in-house adhesive evaluation was conducted due to problems in acquiring adhesives and procuring an ultra-low temperature freezer for storage of these shelf-life limited materials. With much industry input and support, the adhesive document was released as a MIL-STD-883 test method and not as a separate specification as earlier anticipated. Funding for the project was cancelled and the project was terminated.

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FOREWORD

This in-house work unit entitled "High Quality Adhesive Analysis," JON 2338014U, was initiated in Oct 83 by Lt William C. Stewart, the principal and sole investigator. The evaluation was terminated in Jul 86 and funding was cancelled. A final technical report was not prepared by Lt Stewart. The bulk of the work associated with developing an adhesive specification was conducted under JON 233801S1. The following summary documents the objective, approach and results of work unit 2338014U.

INTRODUCTION

In military microcircuits, organic component and substrate attach adhesive are primarily limited to hybrid devices due to the high processing temperatures associated with monolithic devices. The inclusion of organic materials in microcircuits for military and space systems has posed serious reliability hazards where meticulous quality control has not been imposed. In some instances the presence of organic adhesives has accelerated failure mechanisms within the microcircuit due to moisture and solvent outgassing. In other instances failure mechanisms have been directly attributed to the adhesive. Field problems, which demonstrated the impact adhesives could have on reliability, necessitated the development of specific requirements for organic adhesives used in high reliability microcircuits.

OBJECTIVE

The purpose of this in-house evaluation was to characterize organic adhesives used or being considered for use in microelectronic packages. The various characterization studies, such as physical, mechanical and thermal analysis, would provide data on adhesive properties that might impact long term microelectronic reliability. Additionally, these characterization studies would identify the critical parameters to be controlled, define the quantitative limits associated with them, and ultimately be used in developing an organic adhesive specification.

APPROACH

Characterization studies were to begin with a differential scanning calorimetry (DSC) analysis of the organic adhesives to determine if manufacturers suggested cure schedules were adequate to ensure optimum adhesive performance. This would be followed by ultragravimetric microbalance analysis to determine moisture absorption characteristics of each current and proposed adhesive. Lastly, the chemical compounds used to manufacture the adhesive (epoxide resin, accelerators, stabilizers, fillers and curing agents) would be evaluated to determine if residual, unreacted species could affect microcircuit reliability.

RESULTS

From the outset, acquiring adhesives and procuring an ultra-low temperature freezer for storage of these shelf-life limited materials was a significant factor. Since adhesives could not be procured in a timely fashion, characterization studies could not be conducted and results, therefore, were not forthcoming. The bulk of the funds and manhours charged against this work unit were expended in procuring thermal analysis equipment and the ultra-low temperature freezer. An evaluation of the thermal stability and outgassing products of a widely used substrate attach adhesive was conducted jointly with an outside contractor (Singer-Kearfott). The results of this study were included in a jointly authored paper entitled MIL-A-87172: A New Mil Spec for Microelectronic Adhesives. Development of an adhesive specification continued under JON 233801S1 even though the in-house evaluation basically came to a standstill. This was a joint effort on the part of adhesive suppliers, hybrid manufacturers and RADC. An existing NASA adhesive specification, MSFC 592, was used as the framework for developing a more realistic and comprehensive specificaton that would be acceptable and useable by all affected parties. Drawing upon applicable portions of other adhesive specifications, ASTM methods and adhesive supplier in-house procedures, a new, comprehensive adhesive specification, MIL-A-87172, was developed. MIL-A-87172 was not released as anticipated because of problems with having an adhesive specification within FSC 5962. Therefore, the document was reformatted as a test method and was released as test method 5011 in Notice 5 of MIL-STD-883.

CONCLUSION

In-house work unit 2338014U produced almost no technical data during the period of effort. Procuring adhesives for evaluation and an ultra-low temperature freezer for storage of the adhesives consumed most of the funds and manhours expended against this work unit. However, the objective of this effort, development of an adhesive specification, was accomplished via the ongoing specificaton and standardization work under JON 233801SI.

ATTACHMENT 1

METHOD 5011

EVAULATION AND ACCEPTANCE PROCEDURES FOR POLYMERIC ADHESIVES

1. PURPOSE. This method establishes the minimum inspection procedures and acceptance criteria for polymeric adhesives used in microcircuit applications. These adhesives shall be classified into two types as follows:

a. Type I being electrically conductive.

b. Type II being electrically insulative.

2. APPARATUS. Suitable measurement equipments necessary to determine compliance with the requirements of the applicable acquisition document and other apparatus as required in the referenced test methods.

3. PROCEDURES.

3.1 Adhesive procurement specification. The microcircuit manufacturer shall prepare a acquisition specification describing the detailed electrical, mechanical, chemical, and thermal requirements of the adhesive to be acquired. The requirements shall not be less than those imposed by this method, but may be increased to reflect the specific parameters of a particular adhesive or the requirements of a particular application.

3.2 Certificate of compliance. The adhesive supplier shall provide a certificate of compliance for each adhesive order. This certificate shall contain the actual test data for the supplier's testing as prescribed in this document.

3.3 Evaluation procedures. Evaluation procedures for adhesives shall be performed as specified in 3.4.1 through 3.5.12 for the type of adhesive being tested.

3.4 Properties of uncured adhesive.

3.4.1 Materials. The adhesive components and/or system shall be examined in accordance with 3.8.1 and shall be uniform in consistency and free of lumps for foreign material. Any filler shall remain uniformly dispersed and suspended during the required pot life (see 3.8.3). The electrically conductive fillers used in type I adhesives shall be gold, silver, alloys of gold or silver, or other precious metals.

3.4.2 Viscosity. The viscosity of paste adhesives shall be determined in accordance ith 3.8.2. The viscosity, including an acceptable range, shall be specified in the adhesive acquisition document.

3.4.3 Pot life. The pot life shall be determined in accordance with 3.8.3 and shall be a minimum of one hour. The adhesive shall be used within the pot life period after removal from the container, after mixing, or after thawing to room temperature in the case premixed frozen adhesives.

3.4.4 Shelf life. The shelf life, defined as the time that the adhesive continues to meet the requirements of this specification, shall be determined in accordance with 3.8.4. The shelf life shall be a minimum of twelve months at -40°C for one component systems and a minimum of 12 months at room temperature for two component systems. No adhesive shall be used after the expiration date.

3.4.5 Infrared spectrum. An infrared spectrum of the uncured adhesive prepared for application, and of the individual components for a two-component system, shall be obtained in accordance with 3.8.5. A copy of the infrared spectrum shall be provided by the adhesive supplier as part of the certificate of compliance.

3.4.5.1 Infrared spectrum for acceptance testing. After baseline correction, all peak ratios of the spectrum shall not differ by more than ±10 percent from the original spectrum. Any shift, disappearance, or appearance of absorption bands throughout the specified wavelength range (2.5 to 15 micrometers) of the spectrum indicates changes in the chemcial composition of the adhesive and shall be cause for rejection.

3.5 Properties of cured adhesive.

3.5.1 Adhesive cure. The adhesive must be capable of meeting the requirements of this document when cured according to the suppliers's instructions. The cure schedule for supplier tests shall be identical for all tests and shall be reported. The cure schedule for the user tests shall be the minimum cure schedule and minimum pre-seal bake specified in the user's assembly document and shall be reported.

3.5.2 Thermogravimetric analysis (TGA).

3.5.2.1 Thermal stability. The thermal stability of the cured adhesive shall be determined in accordance with 3.8.6. The weight loss at 300°C shall be ≤1.0 percent of the cured adhesive weight.

3.5.2.2 Filler content. Adhesives using a filler to promote properties such as electrical and thermal conductivity shall be tested in accordance with 3.8.6 to determine the inorganic filler content. For acceptance testing, the percent filler content shall not differ from the filler content in the certified material by more than 2 percent.

3.5.3 Outgassed materials. The outgassing of the cured adhesive shall be determined in accordance with 3.8.7. The outgassed moisture shall be ≤ 3000 ppm as determined in 3.8.7.1. Other gaseous species present in quantities ≥ 100 ppm (0.01 percent) shall be reported in ppm or percent. The data obtained in 3.8.7.2 shall also be reported.

3.5.4 Ionic impurities. The ionic impurity content shall be determined in accordance with 3.8.8 and shall meet the requirements specified in table I.

TABLE I. Ionic impurity requirements.

Total ionic content (specific electrical conductance)	≤4.50 millisiemens/meter
Hydrogen (pH)	4.0 ≤ pH ≤ 9.0
Chloride	≤ 300 ppm
Sodium	≤ 50 ppm
Potassium	≤ 50 ppm

Other ions present in quantities > 5 ppm shall be reported in ppm.

3.5.5 Corrosivity. The corrosive effects of adhesives on chip metallization shall be determined in accordance with 3.8.9. There shall be no change in the light transmissibility of the aluminized Mylar in the areas where the adhesive was applied when checked without magnification.

3.5.6 Bond strength. The bond strength of adhesives shall be determined in accordance with 3.8.10 at 25°C, at 150°C, and 25°C after 1000 hours at 150°C. The average bond strength shall be a minimum of 6.0 meganewton/square meter at each test condition.

3.5.7 Coefficient of linear thermal expansion. The coefficient of linear thermal expansion shall be determined form -65°C to 150°C in accordance with 3.8.11. The coefficient of linear thermal expansion shall be ≤65.0 micrometer/meter-°C below the glass transition temperature and <300.0 micrometer/meter-°C above the glass transition temperature (if less than 150°C). This requirement shall not apply to glass supported film adhesives.

3.5.8 Thermal conductivity. The thermal conductivity shall be determined at 121°C ±5°C in accordance with 3.8.12. The thermal conductivity shall be ≥1.5 watt/meter-K for type I adhesives and ≥0.2 watt/meter-K for type II adhesives.

3.5.9 Volume resistivity. The volume resistivity shall be determined in accordance with 3.8.13. The volume resistivity of type I adhesives at 25°C, at 60°C, at 150°C, and at 25°C after 1000 hours at 150°C shall be ≤5.0 microhm-meter for silver-filled adhesives and ≤15.0 microhm-meter for gold-filled adhesives. The volume resistivity of type II adhesives shall be ≥0.1 teraohm-m at 25°C and ≥1.0 megohm-m at 125°C.

3.5.10 Dielectric constant. The dielectric constant of type II adhesives shall be determined in accordance with 3.8.14 and shall be ≤6.0 at both 1 kHz and 1 MHz.

3.5.11 Dissipation factor. The dissipation factor of type II adhesives shall be determined in accordance with 3.8.15 and shall be ≤0.03 at 1 kHz and ≤0.05 at 1 MHz.

3.5.12 Sequential test environment. The adhesive shall withstand exposure to the test conditions specified in 3.8.16. After exposure to the complete sequence of environmental conditions, the test specimens shall show no evidence of mechanical degradation. The measured bond strength shall be a minimum of 6.0-meganewton/square meter.

3.6 Responsibility for testing. The manufacturer and user are responsible for the performance of all tests as specified in table II herein.

NOTE: The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

3.6.1 Test equipment and testing facilities. Test and measuring equipment and testing facilities of sufficient accuracy, quality, and quantity to permit performance of the required testing shall be established and maintained by the manufacturer and user. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-STD-45662.

3.6.2 Testing conditions. Unless otherwise specified herein, all testing shall be performed in accordance with the test conditions specified in the "general requirements" of MIL-STD-883.

3.7 Classification of testing. The test requirements specified herein are classified as certification testing and acceptance testing.

3.7.1 Certification testing. Certification testing shall consist of all tests to determine conformance with all requirements specified herein. To insure that both the adhesive materials and the processes employing the materials are controlled, both the supplier and the user of the adhesives shall be responsible for performance of the tests as designated in table II.

3.7.1.1 Sample size. The number of samples to be subjected to each testing procedure shall be as specified in the individual test methods.

3.7.1.2 Failures. Failure of any of the samples to meet the testing requirements shall be cause for refusal to grant certification approval.

3.7.1.3 Retention of data. The data generated for certification shall be retained for a period of 5 years.

3.7.1.4 Retention of certification. To retain certification, the material shall be re-evaluated at 24-month intervals.

3.7.2 Acceptance testing. Acceptance tests shall be performed on each lot and shall consist of the tests as specified in table II.

3.7.2.1 Test lot. A test lot shall consist of all adhesives manufactured under the same batch number.

3.7.2.2 Sample size. The number of samples to be subjected to each testing procedure shall be as specified in the individual test methods.

3.7.2.3 Failures. Failure of any of the samples to meet the testing requirements shall be cause for rejection of the lot.

3.7.2.4 Retention of data. The data generated for acceptance testing shall be retained for a period of 5 years.

3.8 Methods of examination and test.

3.8.1 Materials. The adhesive components and/or system shall be examined visually at a magnification of 30X to ensure conformance with the requirements of 3.4.1.

3.8.2 Viscosity. The adhesive user and supplier shall defined a mutually acceptable method for verifying the viscosity of paste adhesives. The user and supplier shall use the same method in performing the required certification and acceptance testing.

3.8.3 Pot life. The parameters to be used in the measurement of pot life (e.g., viscosity change, skin-over, loss of bond strength, etc.) are generally material dependent. The adhesive supplier and user shall select the procedure to be used in establishing and testing the pot life.

TABLE II. Requirements for certification and acceptance testing.

Test or condition	Test method paragraph	Responsibility			
		Certification		Acceptance	
		Supplier	User	Supplier	User
Materials (3.4.1)	3.8.1	R	R	R	R
Viscosity (3.4.2)	3.8.2	R		R	
Pot life (3.4.3)	3.8.3	R		R	
Shelf life (3.4.4)	3.8.4	R			
Infrared spectrum (3.4.5)	3.8.5	R		R	
Thermogravimetric analysis (3.5.2)	3.8.6	R		R	
Outgassed materials (3.5.3)	3.8.7		R		
Ionic impurities (3.5.4)	3.8.8	R		R	
Corrosivity (3.5.5)	3.8.9	R	R		R
Bond strength (3.5.6)	3.8.10	R	R		R*
Coefficient of linear thermal expansion (3.5.7)	3.8.11	R			
Thermal conductivity (3.5.8)	3.8.12	R			
Volume resistivity (3.5.9)	3.8.13				
Type I adhesives		R	R*	R*	R*
Type II adhesives		R			
Dielectric constant (3.5.10)	3.8.14	R			
Dissipation factor (3.5.11)	3.8.15	R			
Sequential test environment (3.5.12)	3.8.16		R		

R = Required

R* = Required at 25°C test condition only
(No high temperature storage required)

3.8.4 Shelf life. An unopened container of material shall be stored under the condition specified in 3.4.4. As a minimum, the test methods and requirements specified in table III shall be used to establish the shelf life.

TABLE III. Shelf life determination.

Property	Requirement	Test method	Condition
Materials	3.3.1	3.8.1	
Pot life	3.3.3	3.8.3	
Infrared spectrum	3.3.5	3.8.5	
Bond strength	3.4.6	3.8.10	25°C only
Volume resistivity	3.4.9	3.8.13	Type I, 25°C only

3.8.5 Infrared spectrum. An infrared spectrum shall be recorded over the wavelength range of 2.5 to 15 micrometers of the uncured adhesive prepared for application or of the individual components if a two-component system is used. The infrared spectrum shall be generated such that the the most intensive absorption band shall exceed 60 percent transmission but not exceed 90 percent transmission. It will be necessary to separate the filler material from the resin in order to obtain a good spectrum. This may be accomplished by using solvents for resin extraction or with a centrifuge. If a solvent is used, it must be desorbed or blanked out before recording the spectrum.

3.8.6 Thermogravimetric analysis (TGA). The thermal stability of the adhesive and the adhesive filler content shall be determined by testing a 10 milligram sample of the cured adhesive (see 3.5.1) in accordance with ASTM D3850.

3.8.6.1 Thermal stability. The thermal stability of the adhesive shall be determined by heating the specimen from room temperature to not less than 350°C, at a heating rate not to exceed 10°C/minute, in a nitrogen atmosphere with 20 milliliter/minute nitrogen flow. The weight loss at 300°C shall be determined.

3.8.6.2 Filler content. The filler content of adhesives using a filler to promote properties such as electrical or thermal conductivity shall be determined by heating the specimen from room temperature to 600°C, at a heating rate not to exceed 40°C/minute, in an air atmosphere with 20 milliliter/minute air flow. The temperature shall be maintained at 600°C until constant weight is obtained. It is permitted to perform 3.8.6.1, followed by heating from 350°C to 600°C as detailed above. The filler content shall be reported as weight percent of the cured specimen.

3.8.7 Outgassed materials. Six test specimens shall be prepared using gold-plated Kovar packages. (The use of "leadless" packages is permitted to reduce moisture contributions due to package construction.) If the adhesive will be used for substrate attach, a typical size alumina substrate shall be bonded to the package. If the adhesive will be used for component attach; 0.2 centimeter-square, gold-plated Kovar tabs (type I) or alumina chips (type II) sufficient to cover 10 percent of the package base area shall be bonded directly to the package. The adhesive shall be cured using the minimum cure schedule and shall receive the minimum pre-seal bake specified in the assembly document(s) (see 3.5.1). Four empty packages shall be treated identically to those containing the adhesive and shall be baked with them. The packages shall be hermetically sealed in a dry box following the bake.

3.8.7.1 Three packages containing adhesive and two empty packages shall be heated in accordance with MIL-STD-883, method 1008, test condition C. Immediately after the bake, the packages shall then be subjected to ambient gas analysis in accordance with MIL-STD-883, method 1018, procedure 1. In addition to moisture, other gaseous species present in quantities > 100 ppm shall be reported (in ppm or %). The difference between the average moisture content of packages with adhesive and the average moisture content of the empty packages shall be less than 3000 ppm.

3.8.7.2 Three packages containing adhesive and two empty packages shall be heated in accordance with MIL-STD-883, method 1008 for 1000 hours at 150°C. Immediately after the bake, the packages shall be subjected to ambient gas analysis in accordance with MIL-STD-883, method 1018, procedure 1. In addition to moisture, other gaseous species present in quantities > 100 ppm shall be reported (in ppm or %).

3.8.8 Ionic impurities. A water-extract analysis shall be performed to determine the level of ionic contamination in the adhesive. The total ion content (specific electrical conductance) and the specific ionic content for the hydrogen (pH), chloride, sodium, and potassium ions shall be measured. Other ions present in quantities > 5 ppm shall also be reported in ppm.

3.8.8.1 Sample preparation. Adequate adhesive shall be cured to obtain three, three-gram samples following grinding. The adhesive shall be cured on teflon film in a forced draft oven. The cured specimen shall be removed from the teflon film and ground to 60 mesh particles.

3.8.8.2 Extraction procedure. Three grams of the ground adhesive shall be added to each of three cleaned, tared, 250-ml flasks made of pyrex, or equivalent. The weight of the cured adhesive in each flask shall be recorded to the nearest milligram. 150.0 grams of deionized water with a measured specific conductance $\leq$ 0.1 millisiemens/meter (specific resistivity $\geq$ 1.0 megohm-centimeter) shall be added to each flask. A blank shall be prepared by adding 150.0 grams of the dionized water and a boiling chip to a fourth 250-ml flask. The four flasks shall be refluxed for 20 hours.

NOTE: 1.0 mho = 1.0 siemens; 1.0 mho/cm = 100.0 siemens/meter

3.8.8.3 Measurement of ionic content.

3.8.8.3.1 Total ionic content. The total extractable ionic content shall be determined by measuring the specific electrical conductance of the three, water-extract samples and the blank using a conductivity meter with an immersion conductivity cell having a cell constant of 0.01/centimeter. The total ionic content, in siemens/meter, shall be obtained by subtracting the specific conductance of the blank from the average specific conductance of the three samples.

3.8.8.3.2 Hydrogen ion content (pH). The pH of the water extract shall be determined using a pH meter with a standard combination electrode.

3.8.8.3.3 Specific ion analysis. Specific ion analysis of the water extract shall be conducted using ion chromatography. The ion concentrations in the extract shall be converted to the sample extractable concentrations by multiplying by the ratio of the deionized water weight (W) to adhesive sample weight (S); that is, by (W/S). The chloride, sodium, and potassium ion levels and all other ions present in quantities > 5 ppm shall be reported in ppm.

3.8.9 Corrosivity.

3.8.9.1 Paste adhesives. A small sample of the uncured adhesive (already mixed if it is a two-part adhesive) shall be smeared on the aluminum side of a sheet of aluminized (50 to 75 angstroms thick) Mylar. After 48 hours, the adhesive shall be washed off with acetone, and the light transmissibility of the aluminized Mylar shall be examined by holding the material to a light source. Any change in light transmissibility in the areas where the adhesive was smeared indicates that the adhesive has attacked the aluminum and will be grounds for failure.

3.8.9.2 Film adhesives. For film adhesives, a small sample of the adhesive shall be cured on the aluminum side of the aluminized Mylar specified above. After 48 hours the light transmissibility of the samples shall be examined. Unless the adhesive is transparent, signs of corrosion will be most apparent around the periphery of the adhesive. Any change in light transmissibility will be grounds for failure.

3.8.10 Bond strength. The bond strength of adhesives shall be determined in accordance with 3.8.10.1 or 3.8.10.2 below. As a minimum, five specimens shall be tested to failure at the following conditions:

a. At 25°C
b. At 150°C
c. At 25°C after 1000 hours at 150°C in an air or nitrogen ambient.

The average bond strength at each test condition shall be determined in newton/square meter.

3.8.10.1 The bond strength shall be determined in accordance with method 2019 of MIL-STD-883 using 0.2 centimeter-square, gold-plated Kovar tabs (type I adhesives) or alumina chips (type II adhesives) bonded to either a gold metallized substrate or a gold plated Kovar package. Fillets shall be removed prior to testing.

3.8.10.2 The bond strength shall be determined in accordance with ASTM D1002 using gold-metallized tensile coupons.

NOTE: 1 inch = 2.54 cm; 1 kgf = 9.8065 N; 1 kgf/sq inch = 15.2 kN/sq m

3.8.11 Coefficient of linear thermal expansion. The coefficient of linear thermal expansion shall be determined in accordance with ASTM D3386 over the temperature range of -65°C to 150°C. The glass transition temperature, coefficients, and temperature ranges corresponding to different slopes of the curve shall be noted.

3.8.12 Thermal conductivity. The thermal conductivity, in watt/meter-K, shall be determined at 121 ±5°C in accordance with ASTM C117 or ASTM C518.

NOTE: 1 cal/cm-sec-K = 418.4 W/m-K

3.8.13 Volume resistivity.

3.8.13.1 Type I adhesives. Test specimens shall be prepared using a standard 1 inch x 3 inch glass slide. A jig capable of holding this slide, with two scribed lines 100 mil apart and parallel to the length, shall be the guide for applying two strips of transparent tape. There shall be no wrinkles or bubbles in the tape. The slide shall be cleaned with methanol and air dried. A drop of the type I adhesive shall be placed between the two strips of tape. Using a single-edge razor blade maintaining a 30 degree angle between the slide surface and the razor blade, the adhesive shall be squeezed between the tape strips. The length of the applied strip shall be at least 2.5 inches. The tape shall be removed, and the adhesive shall be cured according to 3.5.1. After cure, the test specimens shall be allowed to cool to room temperature. Resistance measurements shall be made using a milliohm meter in conjunction with a special four-point probe test fixture. (This fixture can be made of an acrylic material with four spring-loaded contacts. The contacts must be set into the acrylic so that the current contacts are 2 inches apart, the voltage contacts are between the two current contacts, and the voltage contacts are separated from each current contact by 0.5 inch.) The four-point probe fixture shall be placed on the strip of conductive adhesive and contact between each probe and the adhesive shall be ensured. The measured resistance shall be recorded in ohms, and the resistivity shall be determined from the following formula:

$$P = R \frac{(w \times t)}{l}$$

where

P = resistivity, ohm-m
R = measured resistance, ohms
w = width, (100 mil = 2.54 mm)
t = thickness, (micrometer reading of adhesive plus glass side minus micrometer reading of the glass slide)
l = length between inner pair of probes, (1 inch = 25.4 mm)

A minimum of three specimens shall be tested at 25°C, at 60°C, at 150°C, and at 25°C after 1000 hours at 150°C in an air or nitrogen ambient. The same specimens may be used for each test.

3.8.13.2 Type II adhesives. Type II adhesives shall be tested in accordance with ASTM D257 at temperatures of 25°C and 125°C.

3.8.14 Dielectric constant. The dielectric constant of type II adhesives shall be determined in accordance with ASTM D150 at frequencies of 1 kHz and 1 MHz at room temperature.

3.8.15 Dissipation factor. The dissipation factor of type II adhesives shall be determined in accordance with ASTM D150 at frequencies of 1 kHz and 1 MHz at room temperature.

3.8.16 Sequential test environment. A minimum of ten test specimens shall be subjected to the environmental conditions specified below. Specimens shall be prepared using gold-plated kovar packages. If the adhesive will be used for substrate attach, a typical size alumina substrate shall be bonded to the package. If the adhesive will be used for component attach, 0.2 centimeter-square, gold-plated kovar tabs (type I) or alumina chips (type II) shall be bonded directly to the package. The test specimens shall be exposed to the following environmental conditions in the sequence given:

a. High temperature storage.
(MIL-STD-883, method 1008, 1000 hours at 150°C)

b. Temperature cycling.
(MIL-STD-883, method 1010, condition C, 100 cycles)

c. Mechanical shock.
(MIL-STD-883, method 2002, condition C, Y1 only)

d. Constant acceleration.
(MIL-STD-883, method 2001, condition C, Y1 only)

Following the environmental exposures, the test specimens shall be examined for mechanical degradation. The average bond strength of component attach adhesives shall be determined at 25°C in accordance with 3.8.10.1.

4. SUMMARY. As a minimum, acquisition documents shall specify the following information:

a. Title, number and revision letter of this military standard.

b. Title, number, and revision letter of acquisition specification.

c. Size and number of containers required.

d. Manufacturer's product designation.

e. Request for test data.

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